# Biodiesel: Is It Viable?
# A Demonstration Project

Author: Kelly Strebig

The Energy Policy Act of 1992 (EPAct) requires federal agencies to purchase specific quantities of alternative fuel vehicles. EPAct names neat (100%) biodiesel as an approved alternative fuel. Biodiesel does not require any engine modifications or special refueling equipment. It can be used in unaltered production-line diesel pickups and vans, so the vehicle purchase price does not go up and the resale value of the vehicles does not go down. Biodiesel can be domestically produced from any plant or animal oil feedstocks, such as soybeans, so it is renewable. It also shows the potential to reduce emissions.

A joint demonstration project was conducted to study the feasibility of using a biodiesel blend in unmodified, light-duty diesel engine pickup trucks. The Department of the Interior, the Department of Energy (DOE), the General Services Administration (GSA), and the Minnesota Soybean Growers Association participated in the project, which was conducted in the Twin Cities. GSA provided six diesel-powered trucks and three gasoline-powered trucks (the baseline). DOE paid GSA for the differential cost between the normal base model gasoline pickup and the diesel trucks. Through its National Renewable Energy Laboratory (NREL), DOE provided funding for collecting the data and summarizing the results, along with program guidance and coordination. The Minnesota Soybean Growers Association provided the methyl soyate and the storage/refueling tank.

The demonstration began in June 1995 and ended on December 3, 1996—dates chosen to cover two summer driving seasons, but only one winter season. To avoid any potential stalling problems, biodiesel was not used during the coldest, often subzero months of mid-December through March. During the project, data were collected on fuel usage and vehicle maintenance, and one emissions test was performed.

When this project started, DOE had not defined biodiesel or biodiesel blends as an alternative fuel that could meet EPAct requirements. In March 1996, DOE guidelines defined only neat (100%) biodiesel as an alternative fuel. Even though the biodiesel blend used in this project is not considered an alternative fuel under EPAct, the project did yield some valuable information. This summary briefly describes the project and the results.

## Project Methodology

### The Test Vehicles

This demonstration used nine 1995 Ford F250 two-wheel-drive pickup trucks. Six were powered with 7.3-L direct-injection turbodiesel V-8 engines, and three were powered by 5-L gasoline V-8 engines. Three of the six diesel pickup trucks ran on a biodiesel blend (50% methyl soyate and 50% Number 1 petroleum diesel). For comparison purposes, the other three diesels ran on conventional petroleum fuel.

### The Biodiesel

The 50/50 blend was arrived at after negotiation between the National Biodiesel Board (NBB) and DOE. Although DOE originally wished to use a 70% ester blend, NBB members felt that a 20% or 30% blend was more appropriate. Number 1 diesel fuel was used in the blend to achieve a viscosity similar to that of Number 2 diesel fuel and to lower the cloud point, which improves cold weather performance. During the project, fuel samples were analyzed by Analysts Maintenance Laboratories, Inc. of Hoffman Estates, IL, to determine their properties.

## Maintenance and Repairs

All trucks received preventive maintenance as prescribed by Ford. Because the trucks were under warranty during the demonstration, there were no charges for repairs, which made it very difficult to track most repairs. In addition, GSA does not generally track warranty work. We are aware of only two repairs: a shift lever in one of the gasoline-fueled trucks and the replacement of a fuel pump on one of the biodiesel-fueled trucks.

# Project Results

### Data Recording

It was difficult to get the drivers to record the amount of fuel used and the odometer reading when they refuel. The GSA computerized fuel tracking system, which promised to alleviate this problem, is still not operational. A fall-back system of obtaining refueling data from the credit card receipts proved very time-consuming, and is not failsafe because some of the receipts were lost or misplaced before we could analyze them.

### Vehicle Performance

The demonstration proceeded with no major vehicle operational difficulties. The mileage and usage of the nine trucks varied significantly. One gasoline-powered truck accumulated 53,214 miles; another accumulated only 3,733 miles. The highest mileage diesel truck has 13,151 miles and the biodiesel trucks accumulated from 5,617 to 6,432 miles.

One of the biodiesel trucks has started at temperatures of 5°F without using its engine block heater. At these temperatures, the trucks tend to run rough for the first few minutes. The combination of the blend using Number 1 diesel resulted in a cloud point of 15°F and a pour point of -10°F. In addition, the Ford fuel filter heater system has allowed the trucks to run at subzero temperatures.

In January 1996, a biodiesel truck was accidentally left outside in -10°F temperatures overnight with its block heater unplugged. It did not start immediately, but after the engine block heater was plugged in for less than an hour, the truck started and ran fine.

### Lubrication Oil Analysis

In the summer of 1996, the University of Missouri, under contract to the NBB, analyzed 14 oil samples. The samples were taken between June and October of 1996 and analyzed at the Cleveland Technical Center, Kansas City, KS. Only the trucks located in the Twin Cities area were sampled. Review of the data shows no significant difference in the oil between the petroleum and biodiesel trucks

### Fuel Consumption/Mileage

The gasoline vehicles averaged 12.3 mpg, the diesels 17.0, and the biodiesel 15.2. It is generally more appropriate to convert fuel consumption to the same energy basis to compare different fuels. When the full consumption was converted to gallons of gasoline equivalent (so referencing the energy content of gasoline as the base), the fuel economy for the diesels reduced to 15.6 mpg, and the biodiesels reduced to 14.3 mpg.

Comparison of fuel consumption in this type of demonstration can also be misleading unless one looks very carefully at each truck's specific use, so the data must be analyzed with the varied use of the trucks kept in mind.

Taking the gasoline trucks as an example, two of the trucks had the best conditions for high mileage (being used only on the highway), biasing the gasoline mileage to the high side. One was used only on the grounds of the VA Hospital and showed very poor mileage. All the biodiesel trucks were kept in town to enable maximum use of biodiesel fuel and were used only for short trips, which biased their mileage to the low side.

**Emissions Testing**

NREL funded emissions testing on one of the biodiesel trucks in May 1996. Five fuel/blends were tested: 100% petroleum diesel and 25%, 50%, 75%, and 100% methyl soyate. The emissions testing contract was to Automotive Testing Laboratories (ATL) in East Liberty, Ohio; ATL subcontracted the testing to ORTECH in Canada.

Results of this testing showed no major difference in any of the fuel blend ratios. However, this does not agree with other research conducted on heavy-duty engines, which has clearly shown a difference in emissions with different blend ratios. Emission testing done on a similar 7.3-L turbo diesel engine exhibited changes with different blend ratios (see SAE paper 950054, "Emission and Performance Characteristics of a Four Stroke Direct Injected Diesel Engine Fueled with Blends of Biodiesel and Low Sulfur Diesel Fuel," by R.J. Last, M. Krueger, and M. Duernholz).

It may be that significant differences in emissions were not observed (or even a trend with the different blend ratios) because an inadequate amount of time may have been spent conditioning the engine and exhaust system between tests. This would tend to cause all the data to be averaged together and thus disguise any differences. Additional testing would be necessary to draw any definitive conclusions about emissions differences.

**Drivers' Impressions**

All the drivers liked the diesel-powered trucks, noting the high power and brisk acceleration. Comments such as "It's faster than our 454 four-wheel drive Chevy and faster than my F150 with gasoline V8," were typical of drivers' feelings about the diesel trucks. The drivers of the biodiesel trucks said there was no visible smoke and very little odor compared to petroleum diesels. There were a few comments on the higher noise level of the diesels. One minor problem with all diesel trucks is their high torque combined with two-wheel drive, which makes them a challenge to drive on icy roads.

## Summary and Recommendation

In the future, it might be best to place two-wheel-drive diesel pickups in southern climates and place only four-wheel-drive pickups in northern climates. Diesel passenger vans might be fine in northern climates because of their better rear weight distribution. It is also necessary to use the diesels's engine block heater at subzero temperatures, while the gasoline starts in such cold without assistance.

At this point biodiesel appears to be a very viable alternative fuel. The biodiesel industry should work with DOE to arrive at a reasonable blend ratio— acceptable to DOE yet economical for the consumers. The biodiesel industry feels that considering the total energy offset in the production and consumption of biodiesel, a blend as low as 20% is correct. As of late 1996, DOE has only approved a 100% methyl ester biodiesel for further EPAct use. It is unlikely that the engine manufacturer would ever offer a warranty on their diesel engines on 100% esters. Economically it is difficult for biodiesel to compete with ethanol, with its government subsidy, especially if biodiesel is required at high blend ratios. If DOE can establish a blend ratio that takes into consideration the true petroleum offset offered by biodiesel as compared to the other fuels, biodiesel can then be economically competitive on a cost per gallon basis.